

Product Overview

The QPD1016L is a 500 W (P_{3dB}) pre-matched discrete GaN on SiC HEMT which operates from DC to 1.7 GHz and 50 V supply. The device is in an industry standard air cavity package and is ideally suited for IFF, avionics, military and civilian radar, and test instrumentation. The device can support Pulse and CW operations.

ROHS compliant.

Evaluation boards are available upon request.

QPD1016LEVB01 Pulsed Performance

Freq.(GHz)	P_{3dB} (W)	G_{3dB} (dB)	DE_{3dB} (%)
1.2	569.0	15.9	59.4
1.3	549.8	15.0	62.5
1.4	514.4	15.2	64.4

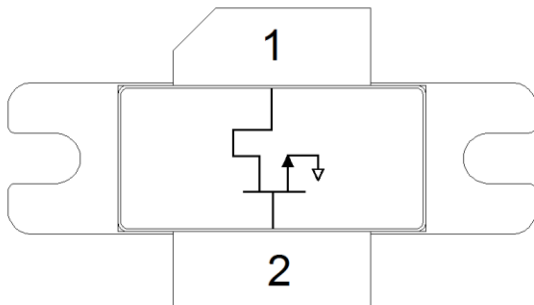
Pulse Signal: Pulse Width = 300us, Duty Cycle = 10%
 $V_D = +50$ V, $I_{DQ} = 1000$ mA, Baseplate Temperature of 25°C

QPD1016EVB01 CW Performance

Freq.(GHz)	P_{3dB} (W)	G_{3dB} (dB)	DE_{3dB} (%)
1.2	342.4	16.4	52.0
1.3	364.4	15.7	58.7
1.4	389.6	15.9	62.6

CW Signal: $V_D = +50$ V, $I_{DQ} = 1000$ mA, Baseplate Temperature of 25°C

Functional Block Diagram



NI-780 Package

Key Features

- Frequency: DC to 1.7 GHz
- Linear Gain¹: 18.0 dB
- Output Power (P_{3dB})¹: 537 W
- Drain Efficiency(P_{3dB})¹: 67.3%
- Operating Voltage: 50 V
- Pulse capable
- CW capable using soldering process

Note 1: @ Typical EVB Performance at 1.3 GHz

Applications

- IFF
- Avionics
- Military and civilian radar
- Test instrumentation

Ordering info

Part No.	Description
QPD1016L	DC – 1.7 GHz, 50 V, 500 W GaN RF Transistor
QPD1016LEVB01	1.2 – 1.4 GHz EVB

Absolute Maximum Ratings^{1,2}

Parameter	Rating	Units
Breakdown Voltage, V_{BDG}	+145	V
Gate Voltage Range, V_G	-7 to +2	V
Drain Current, $I_{D_{MAX}}$	70	A
Gate Current Range, I_G	See page 17	mA
Power Dissipation, P_{DISS}	714 ²	W
RF Input Power, Pulse, 1.3 GHz, $T = 25\text{ }^\circ\text{C}^2$	+45.5	dBm
Mounting Temperature (30 Seconds)	320	$^\circ\text{C}$
Storage Temperature	-65 to +150	$^\circ\text{C}$

Notes:

1. Operation of this device outside the parameter ranges given above may cause permanent damage.
2. Pulsed 300 uS PW, 10% DC

Recommended Operating Conditions¹

Parameter	Min	Typ	Max	Units
Operating Temp. Range	-40	+25	+85	$^\circ\text{C}$
Drain Voltage Range, V_D	+32	+50	+55	V
Drain Bias Current, I_{DQ}		1000		mA
Drain Current, I_D^4	-	16	-	A
Gate Voltage, V_G^3	-	-2.8	-	V
Power Dissipation (P_D) ^{2,4}	-	-	441	W
Power Dissipation (P_D), CW ²	-	-	269	W

Notes:

1. Electrical performance is measured under conditions noted in the electrical specifications table. Specifications are not guaranteed over all recommended operating conditions.
2. Package base at 85 $^\circ\text{C}$
3. To be adjusted to desired I_{DQ}
4. Pulsed, 300uS PW, 10% DC

Measured Load Pull Performance – Power Tuned^{1,2}

Parameter	Typical Values						Units
	1.1	1.2	1.3	1.4	1.5	1.7	
Frequency, F	1.1	1.2	1.3	1.4	1.5	1.7	GHz
Drain Voltage, V_D	50	50	50	50	50	50	V
Drain Bias Current, I_{DQ}	1000	1000	1000	1000	1000	1000	mA
Output Power at 3dB compression, P_{3dB}	58.8	58.6	58.3	58	57.6	58	dBm
Power Added Efficiency at 3dB compression, PAE_{3dB}	71.7	69.2	72.2	76.1	69.9	71.2	%
Gain at 3dB compression, G_{3dB}	21.0	20.6	20.9	21.7	21.0	20.6	dB

Notes:

1. Pulsed, 300 uS Pulse Width, 10% Duty Cycle
2. Characteristic Impedance, $Z_o = 3\ \Omega$.

Measured Load Pull Performance – Efficiency Tuned^{1,2}

Parameter	Typical Values						Units
	1.1	1.2	1.3	1.4	1.5	1.7	
Frequency, F	1.1	1.2	1.3	1.4	1.5	1.7	GHz
Drain Voltage, V_D	50	50	50	50	50	50	V
Drain Bias Current, I_{DQ}	1000	1000	1000	1000	1000	1000	mA
Output Power at 3dB compression, P_{3dB}	57.6	57.1	56.4	57.3	56.1	56.7	dBm
Power Added Efficiency at 3dB compression, PAE_{3dB}	79.2	78.3	77.4	77.8	71.2	73.5	%
Gain at 3dB compression, G_{3dB}	22.2	22.1	22.2	22.3	21.7	21.7	dB

Notes:

1. Pulsed, 300 uS Pulse Width, 10% Duty Cycle
2. Characteristic Impedance, $Z_o = 3\ \Omega$.

1.2 – 1.4 GHz EVB at 1.3 GHz Performance¹

Parameter	Min	Typ	Max	Units
Linear Gain, G_{LIN}	–	18.0	–	dB
Output Power at 3dB compression point, P3dB	–	57.3	–	dBm
Drain Efficiency at 3dB compression point, DEFF3dB	–	67.3	–	%
Gain at 3dB compression point, G3dB	–	15.0	–	dB
Gate Leakage ($V_D = 10V$, $V_G = -3.3V$)	-40			mA

Notes:

1. $V_D = +50V$, $I_{DQ} = 1000mA$, Temp = +25 °C, Pulse Width = 300 uS, Duty Cycle = 10%

RF Characterization – Mismatch Ruggedness at 1.3 GHz^{1,2}

Symbol	Parameter	dB Compression	Typical
VSWR	Impedance Mismatch Ruggedness	3	10:1

Notes:

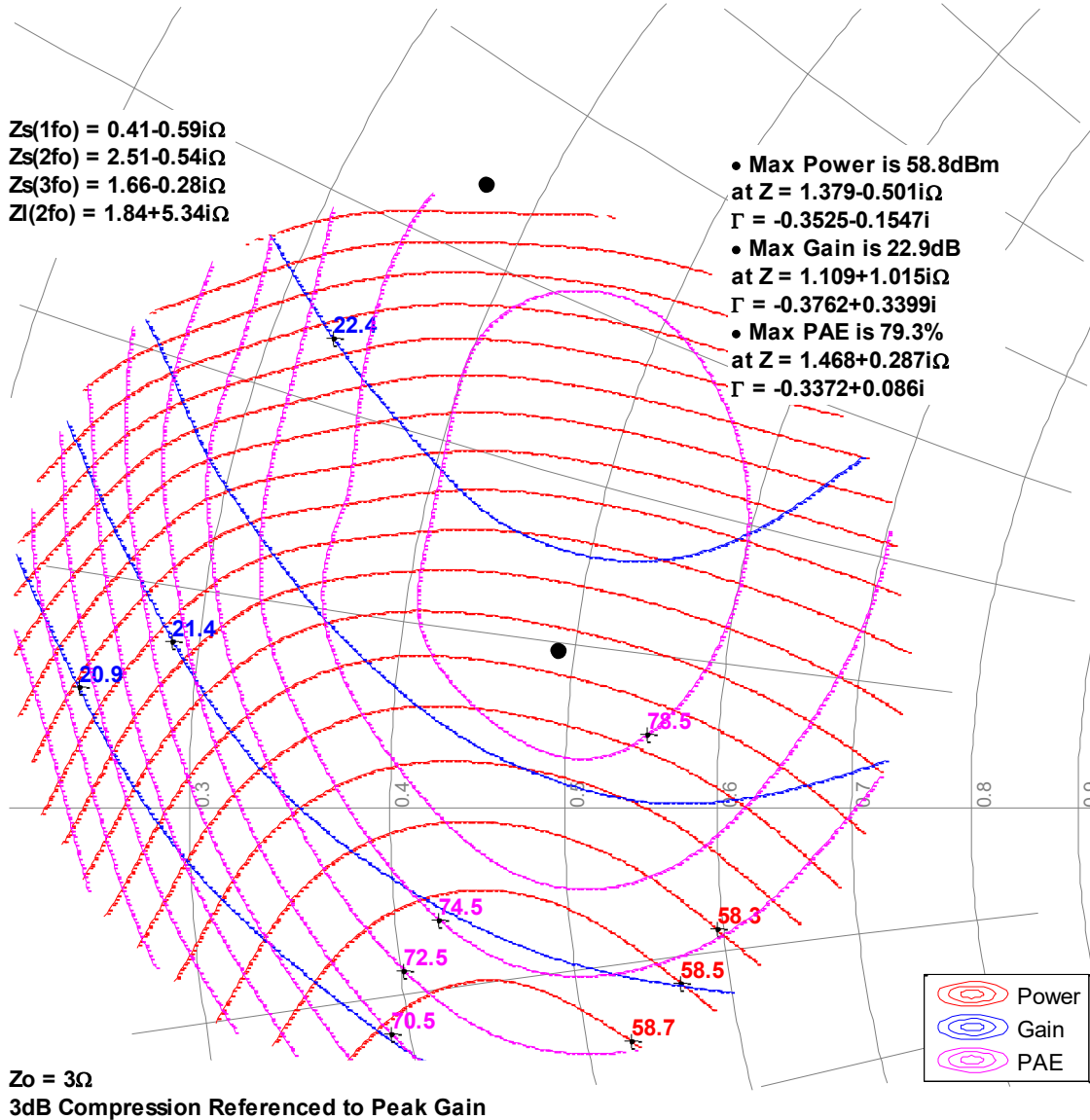
1. Test conditions unless otherwise noted: $T_A = 25\text{ °C}$, $V_D = 50V$, $I_{DQ} = 1000mA$
2. Input drive power is determined at pulsed 3dB compression under matched condition at EVB output connector.

Measured Load-Pull Smith Charts^{1, 2}

Notes:

1. Test Conditions: $V_D = 50\text{ V}$, $I_{DQ} = 1000\text{ mA}$, 300 μs Pulse Width, 10% Duty Cycle
2. See page 18 for load pull reference planes where the performance was measured.

1.1GHz, Load-pull

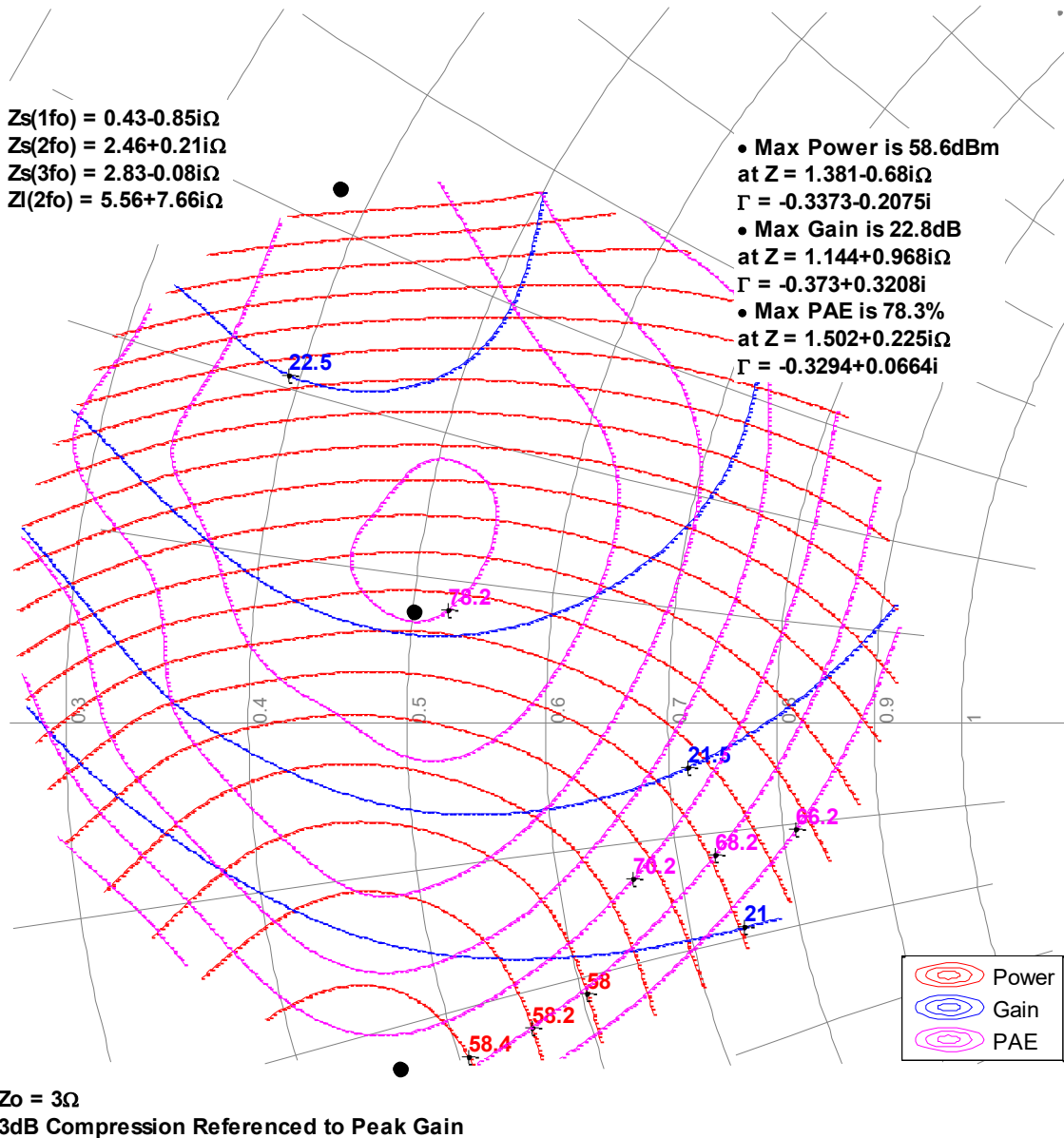


Measured Load-Pull Smith Charts^{1, 2}

Notes:

1. Test Conditions: $V_D = 50\text{ V}$, $I_{DQ} = 1000\text{ mA}$, 300 μs Pulse Width, 10% Duty Cycle
2. See page 18 for load pull reference planes where the performance was measured.

1.2GHz, Load-pull

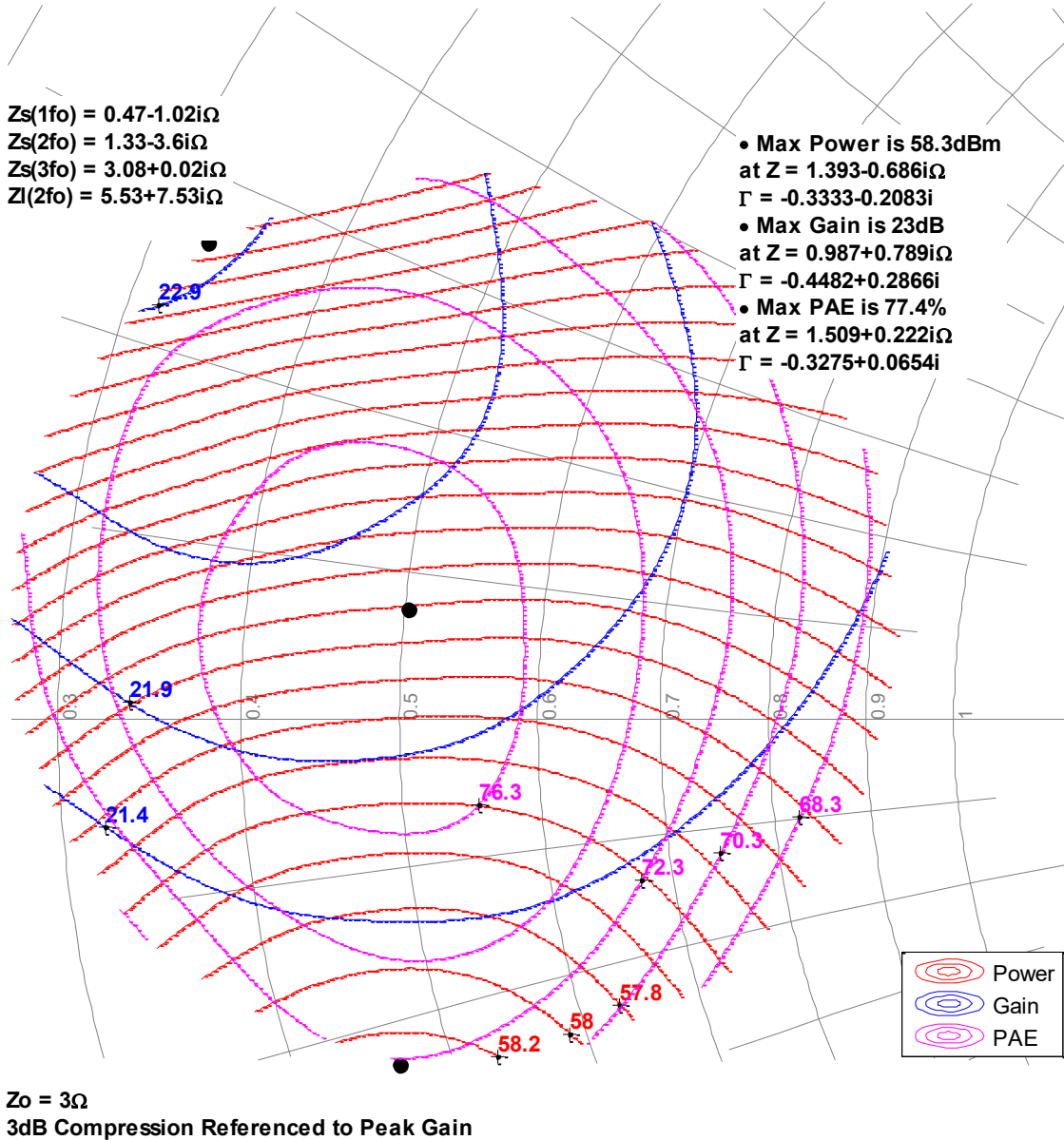


Measured Load-Pull Smith Charts^{1, 2}

Notes:

1. Test Conditions: $V_D = 50\text{ V}$, $I_{DQ} = 1000\text{ mA}$, 300 μs Pulse Width, 10% Duty Cycle
2. See page 18 for load pull reference planes where the performance was measured.

1.3GHz, Load-pull

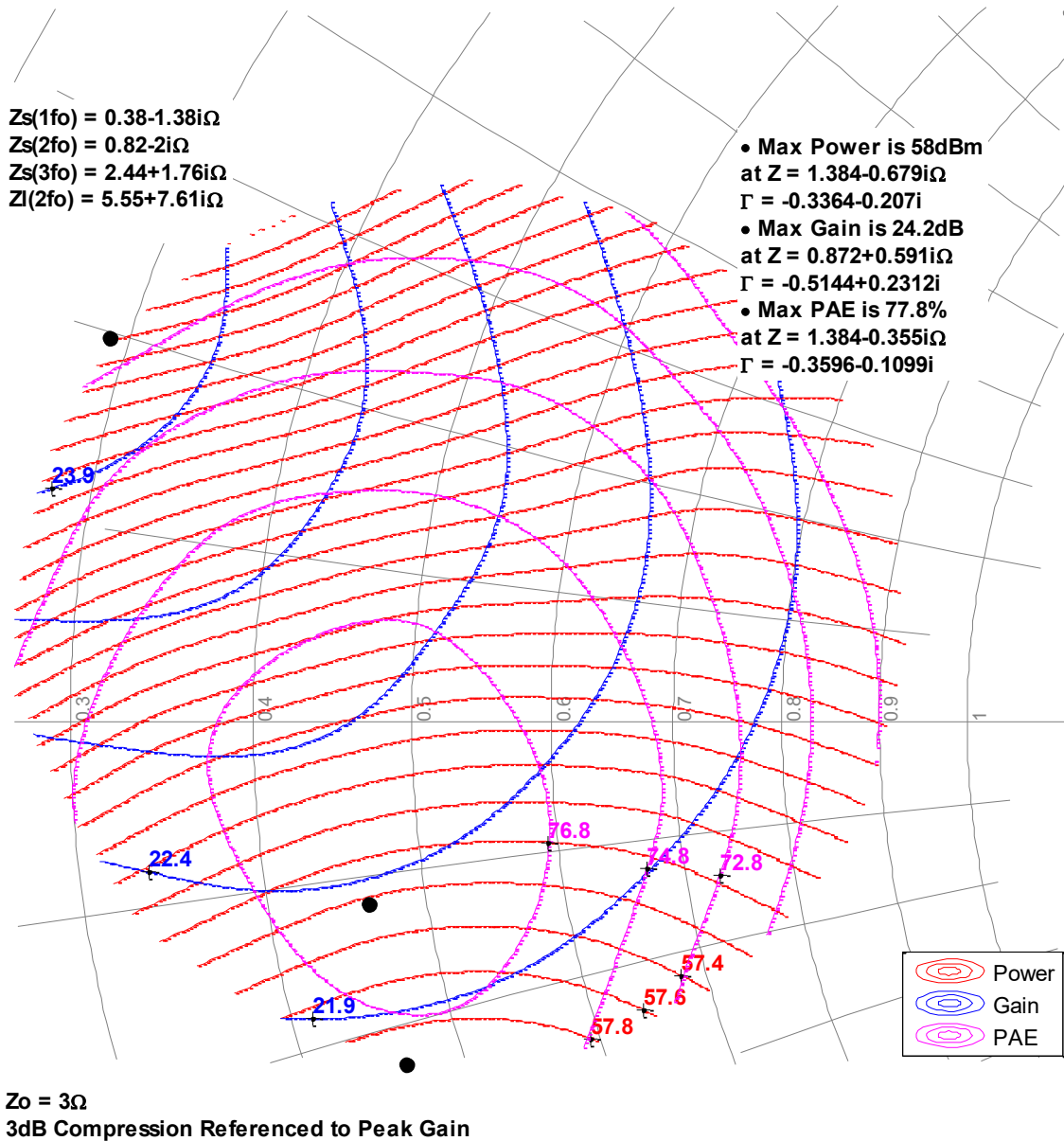


Measured Load-Pull Smith Charts^{1, 2}

Notes:

1. Test Conditions: $V_D = 50\text{ V}$, $I_{DQ} = 1000\text{ mA}$, 300 μs Pulse Width, 10% Duty Cycle
2. See page 18 for load pull reference planes where the performance was measured.

1.4GHz, Load-pull

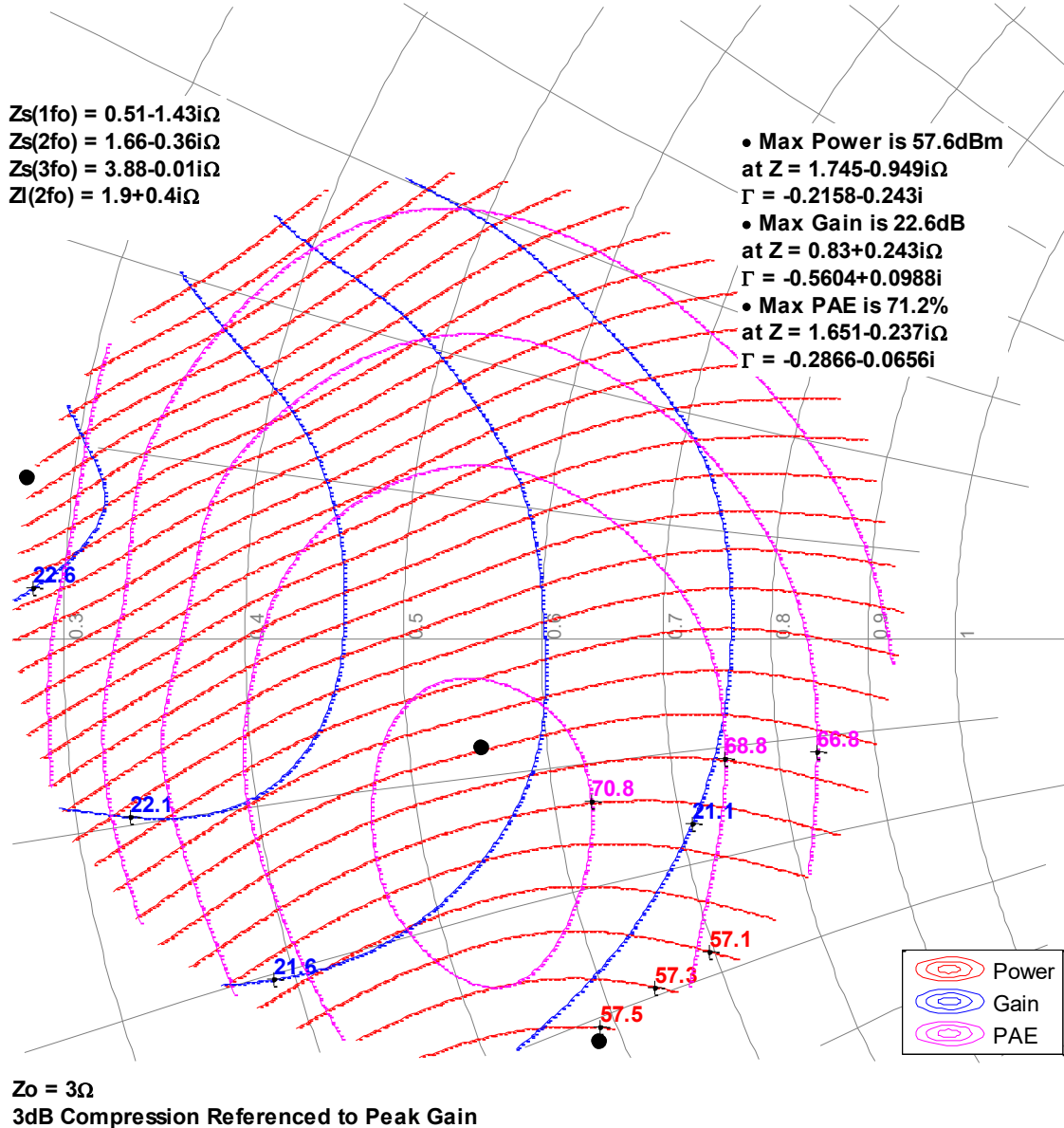


Measured Load-Pull Smith Charts^{1, 2}

Notes:

1. Test Conditions: $V_D = 50\text{ V}$, $I_{DQ} = 1000\text{ mA}$, 300 μs Pulse Width, 10% Duty Cycle
2. See page 18 for load pull reference planes where the performance was measured.

1.5GHz, Load-pull

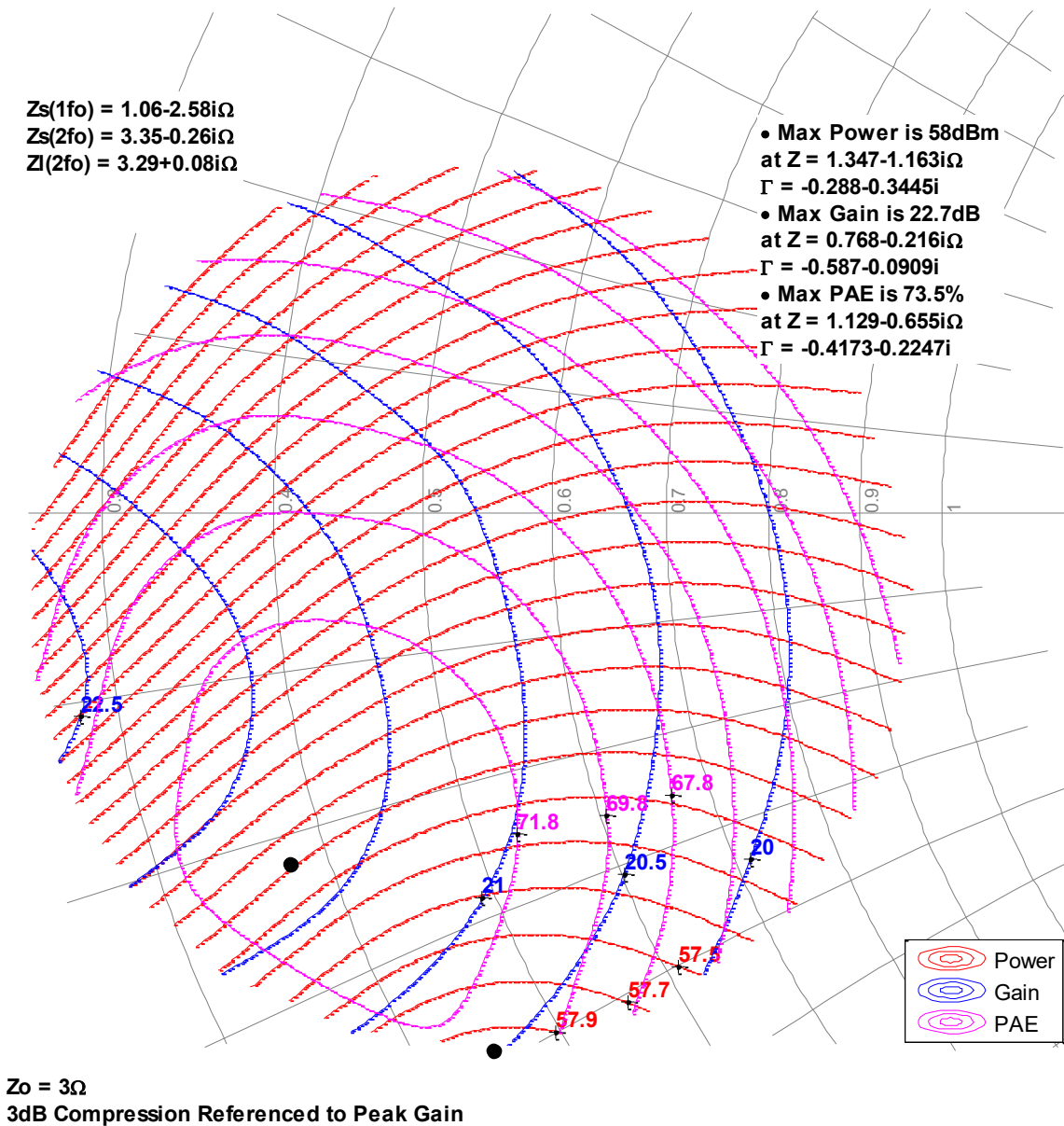


Measured Load-Pull Smith Charts^{1, 2}

Notes:

1. Test Conditions: $V_D = 50\text{ V}$, $I_{DQ} = 1000\text{ mA}$, 300 μs Pulse Width, 10% Duty Cycle
2. See page 18 for load pull reference planes where the performance was measured.

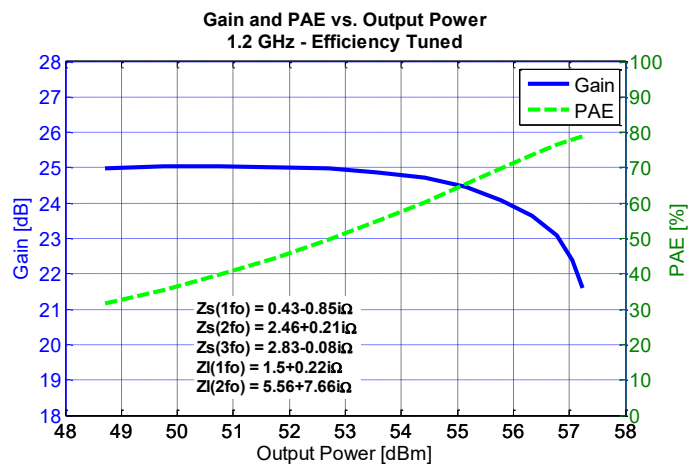
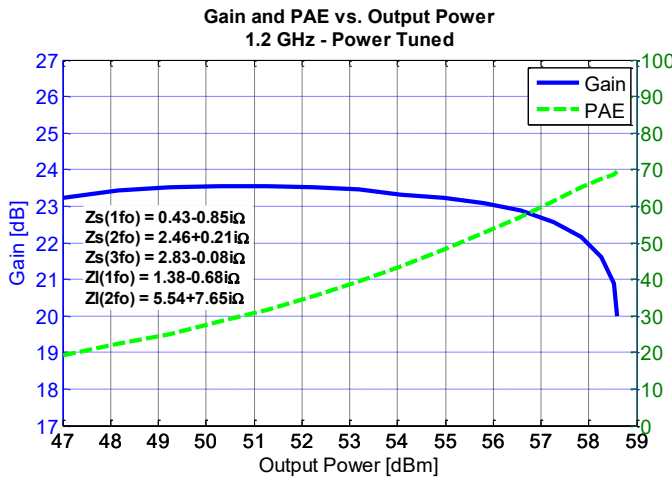
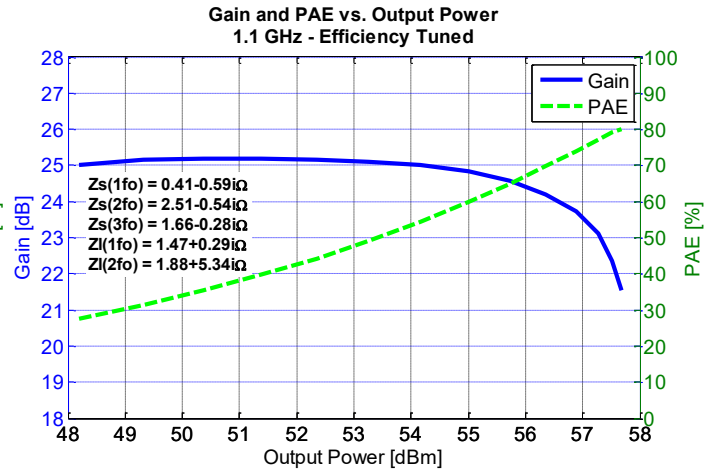
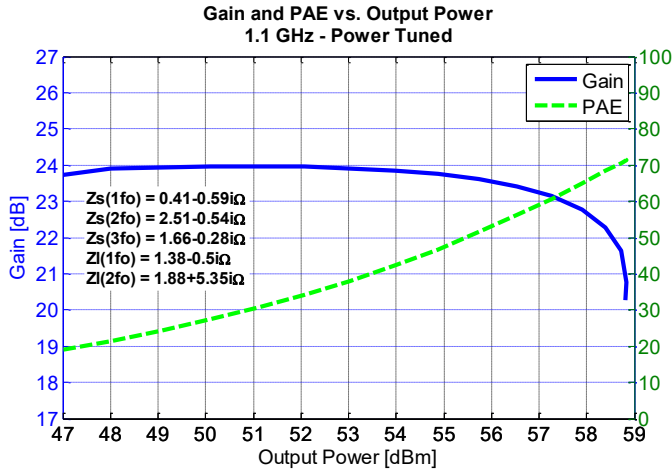
1.7GHz, Load-pull



Typical Measured Performance – Load-Pull Drive-up^{1, 2}

Notes:

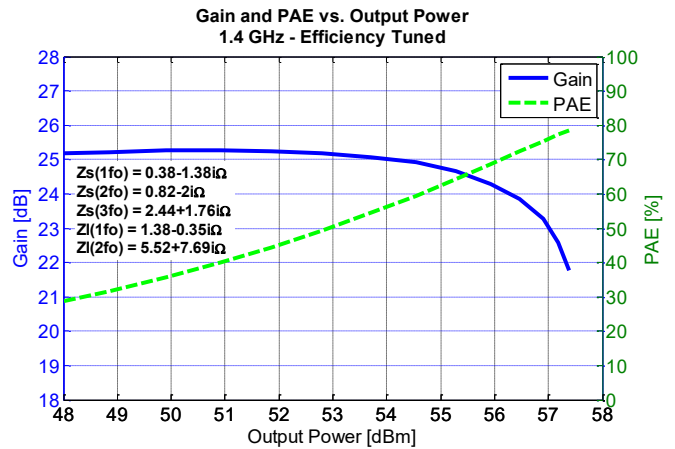
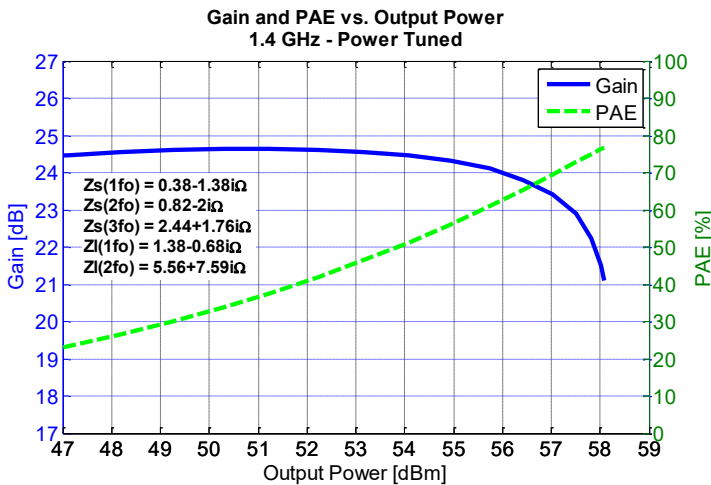
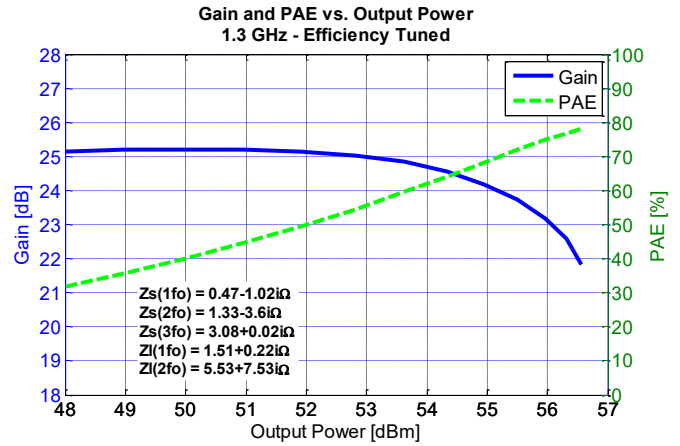
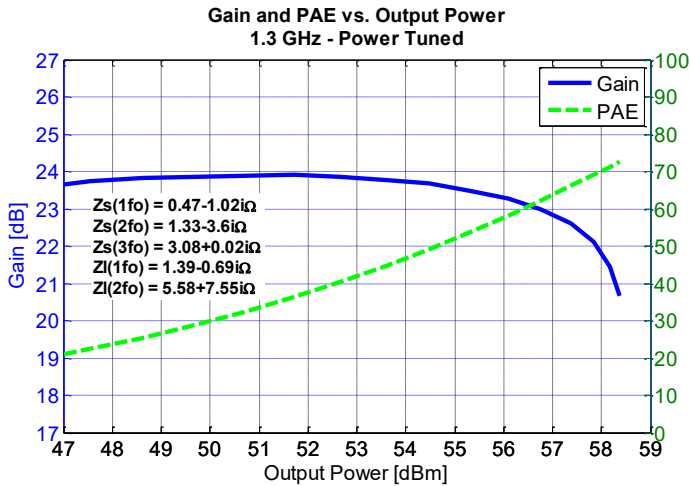
1. Test Conditions: $V_D = 50\text{ V}$, $I_{DQ} = 1000\text{ mA}$, 300 μs Pulse Width, 10% Duty Cycle
2. See page 18 for load pull reference planes where the performance was measured.



Typical Measured Performance – Load-Pull Drive-up^{1, 2}

Notes:

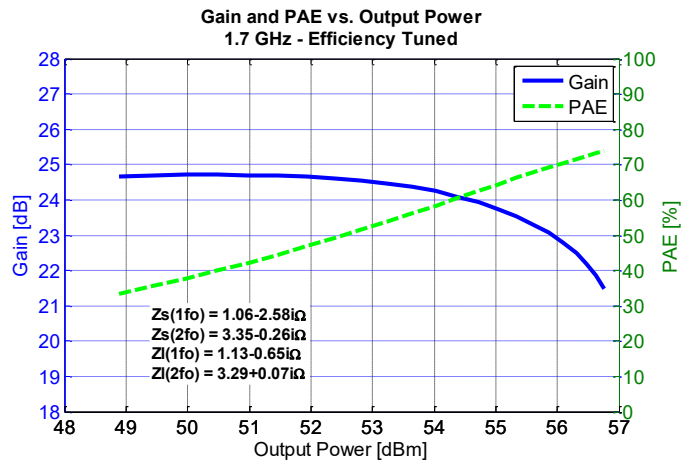
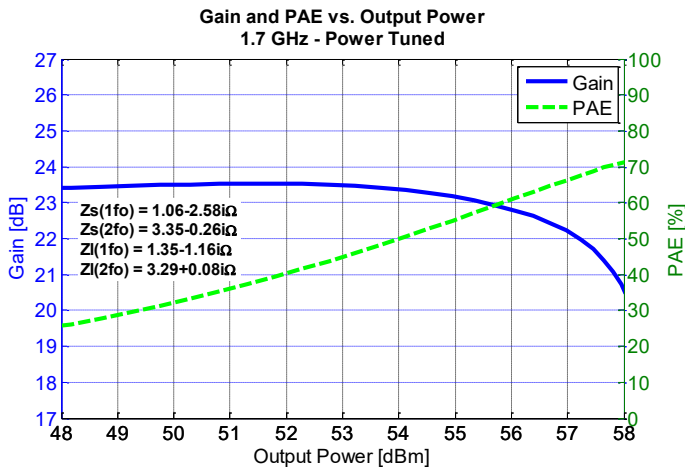
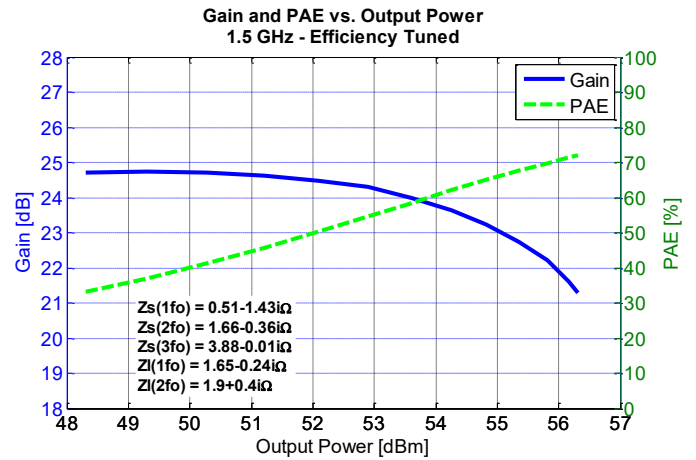
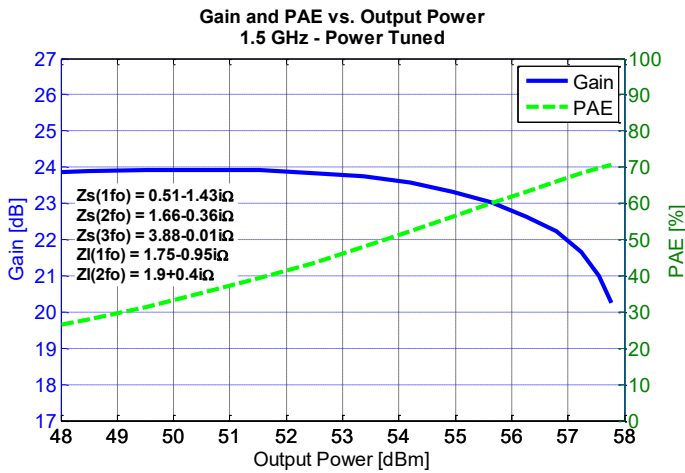
1. Test Conditions: $V_D = 50\text{ V}$, $I_{DQ} = 1000\text{ mA}$, 300 μs Pulse Width, 10% Duty Cycle
2. See page 18 for load pull reference planes where the performance was measured.



Typical Measured Performance – Load-Pull Drive-up^{1, 2}

Notes:

1. Test Conditions: $V_D = 50\text{ V}$, $I_{DQ} = 1000\text{ mA}$, 300 μs Pulse Width, 10% Duty Cycle
2. See page 18 for load pull reference planes where the performance was measured.

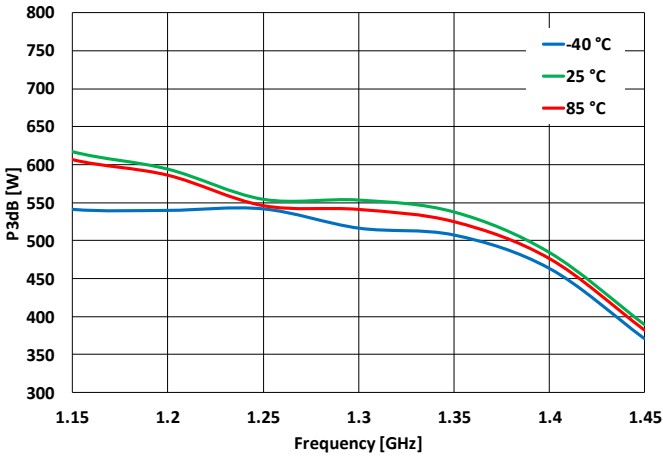


Power Driveup Performance Over Temperatures Of 1.2 – 1.4 GHz EVB ¹

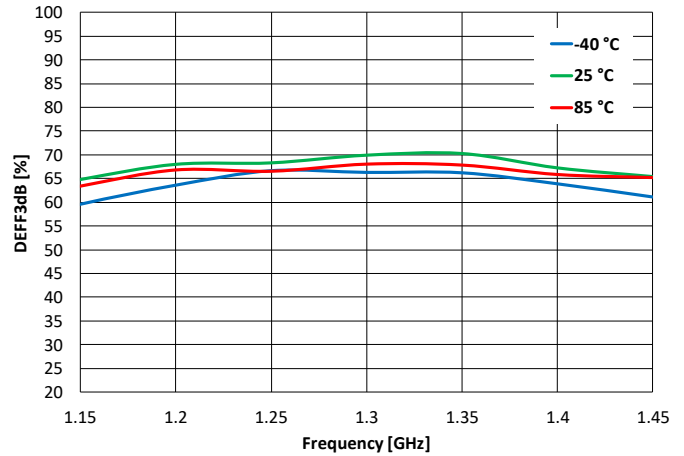
Notes:

1. Test Conditions: $V_D = 50\text{ V}$, $I_{DQ} = 1000\text{ mA}$, 300 μs Pulse Width, 10% Duty Cycle

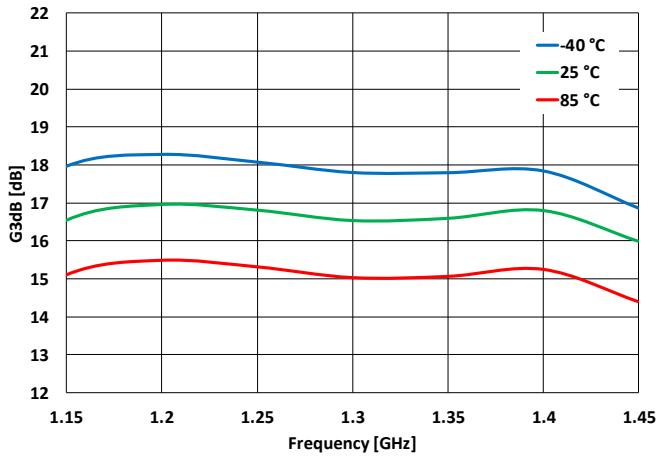
P3dB Over Temperatures



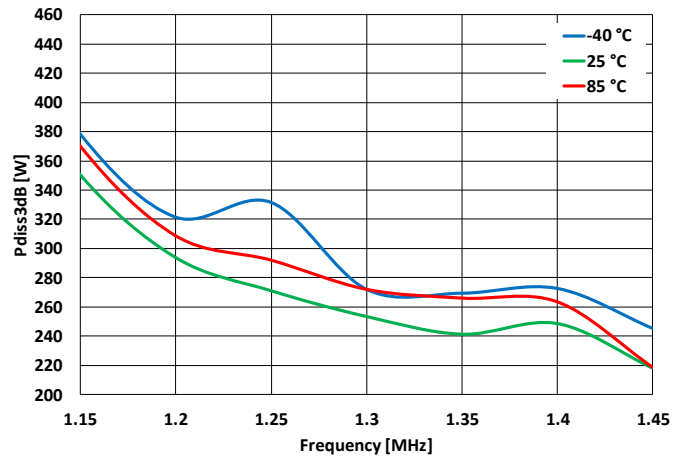
DEFF3dB Over Temperatures



G3dB Over Temperatures



Pdiss3dB Over Temperatures

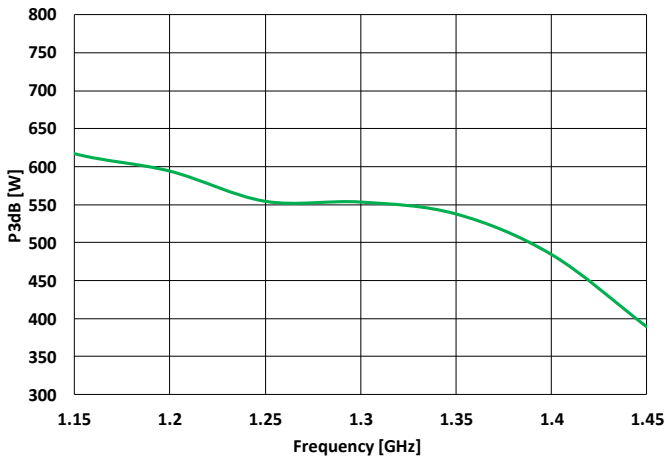


Power Driveup Performance At 25°C Of 1.2 – 1.4 GHz EVB ¹

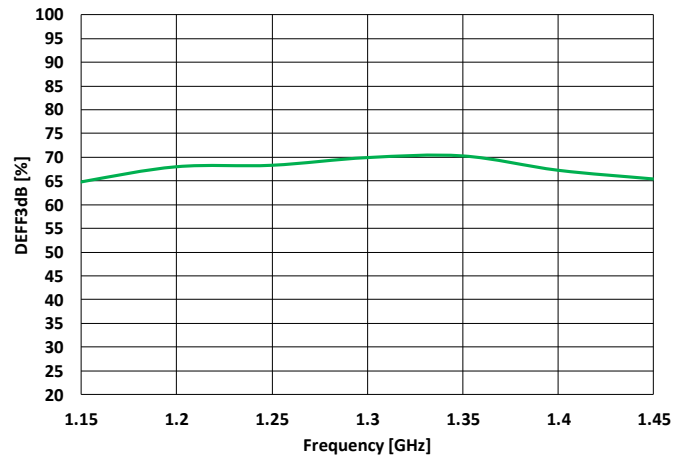
Notes:

1. Test Conditions: $V_D = 50\text{ V}$, $I_{DQ} = 1000\text{ mA}$, 300 μs Pulse Width, 10% Duty Cycle

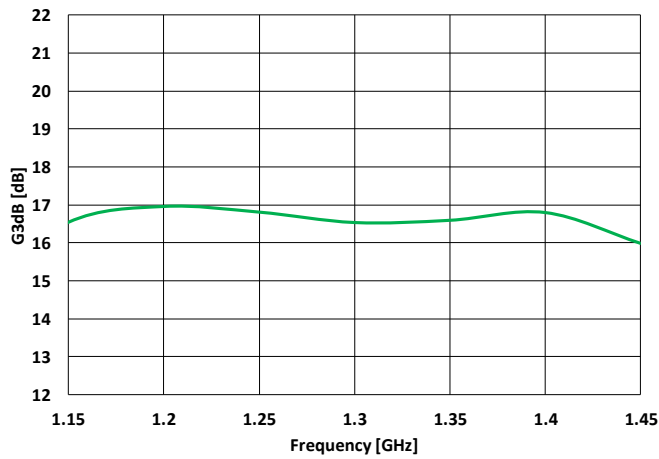
P3dB At 25 °C



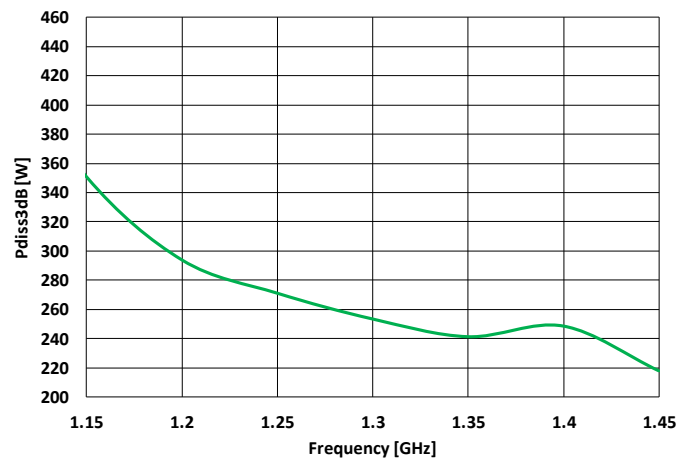
DEFF3dB At 25 °C



G3dB At 25 °C

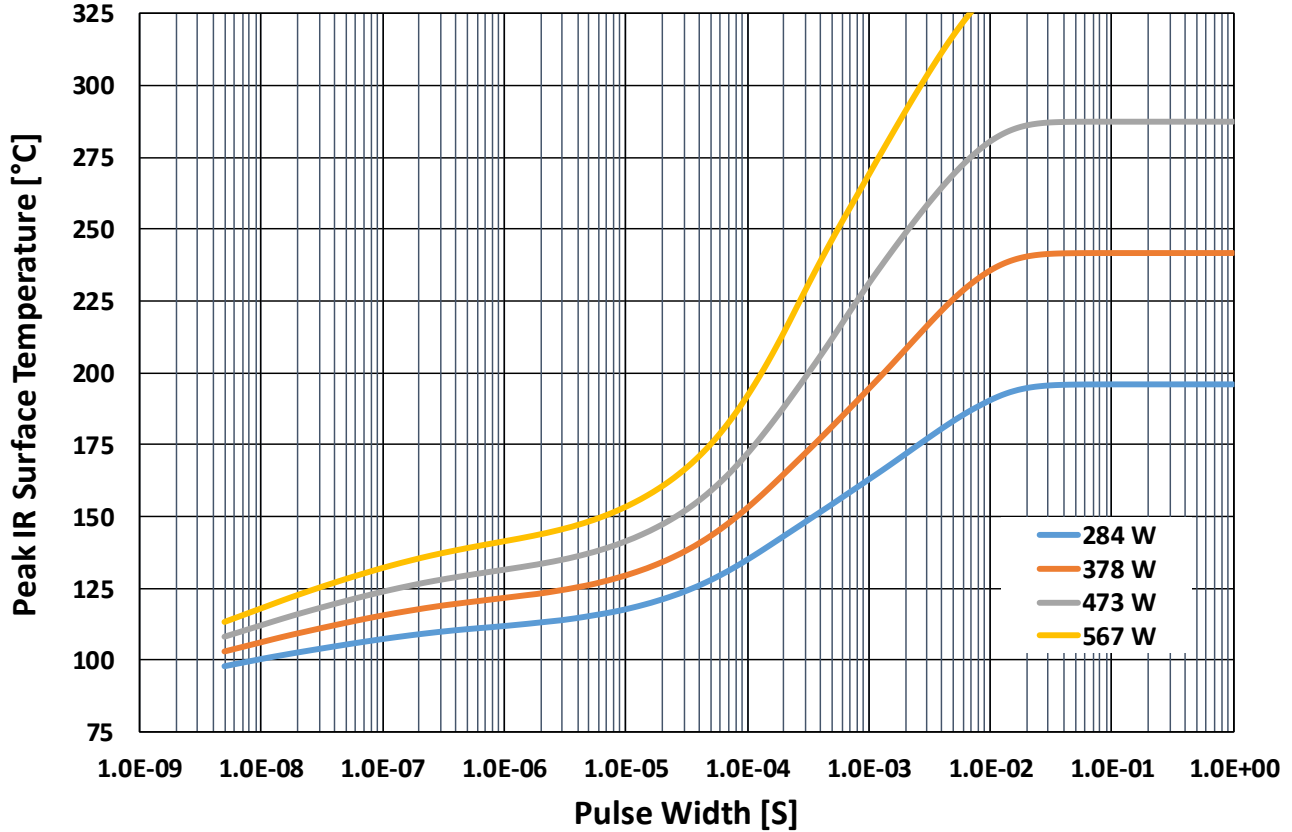


Pdiss3dB At 25 °C



Thermal and Reliability Information – Pulsed ¹

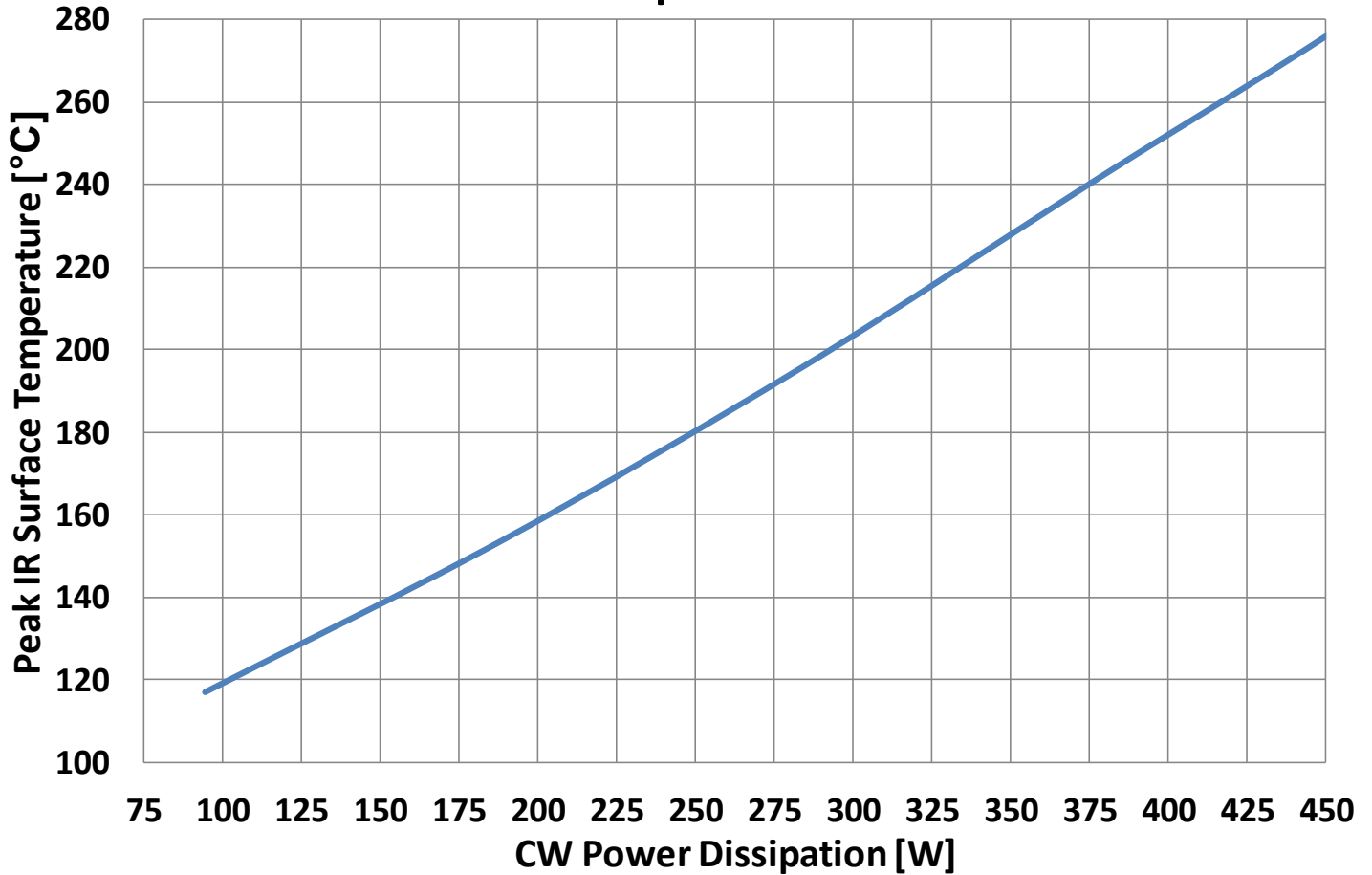
Peak IR Surface Temperature vs. PW vs. Pulsed Dissipation Power
Base Temperature at 85 °C



Parameter ¹	Conditions	Values	Units
Thermal Resistance, IR (θ_{JC})	85 °C Case	0.22	°C/W
Peak Channel Temperature, IR (T_{CH})	284 W P _{diss} , 300 uS PW, 10% DC	148	°C
Thermal Resistance, IR (θ_{JC})	85 °C Case	0.23	°C/W
Peak Channel Temperature, IR (T_{CH})	378 W P _{diss} , 300 uS PW, 10% DC	172	°C
Thermal Resistance, IR (θ_{JC})	85 °C Case	0.24	°C/W
Peak Channel Temperature, IR (T_{CH})	473 W P _{diss} , 300 uS PW, 10% DC	198	°C
Thermal Resistance, IR (θ_{JC})	85 °C Case	0.25	°C/W
Peak Channel Temperature, IR (T_{CH})	567 W P _{diss} , 300 uS PW, 10% DC	228	°C

Notes:

1. Refer to the following document [GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates](#)

Thermal and Reliability Information – CW ¹
**Peak IR Surface Temperature vs. CW Power
Base Temperature at 85 °C**


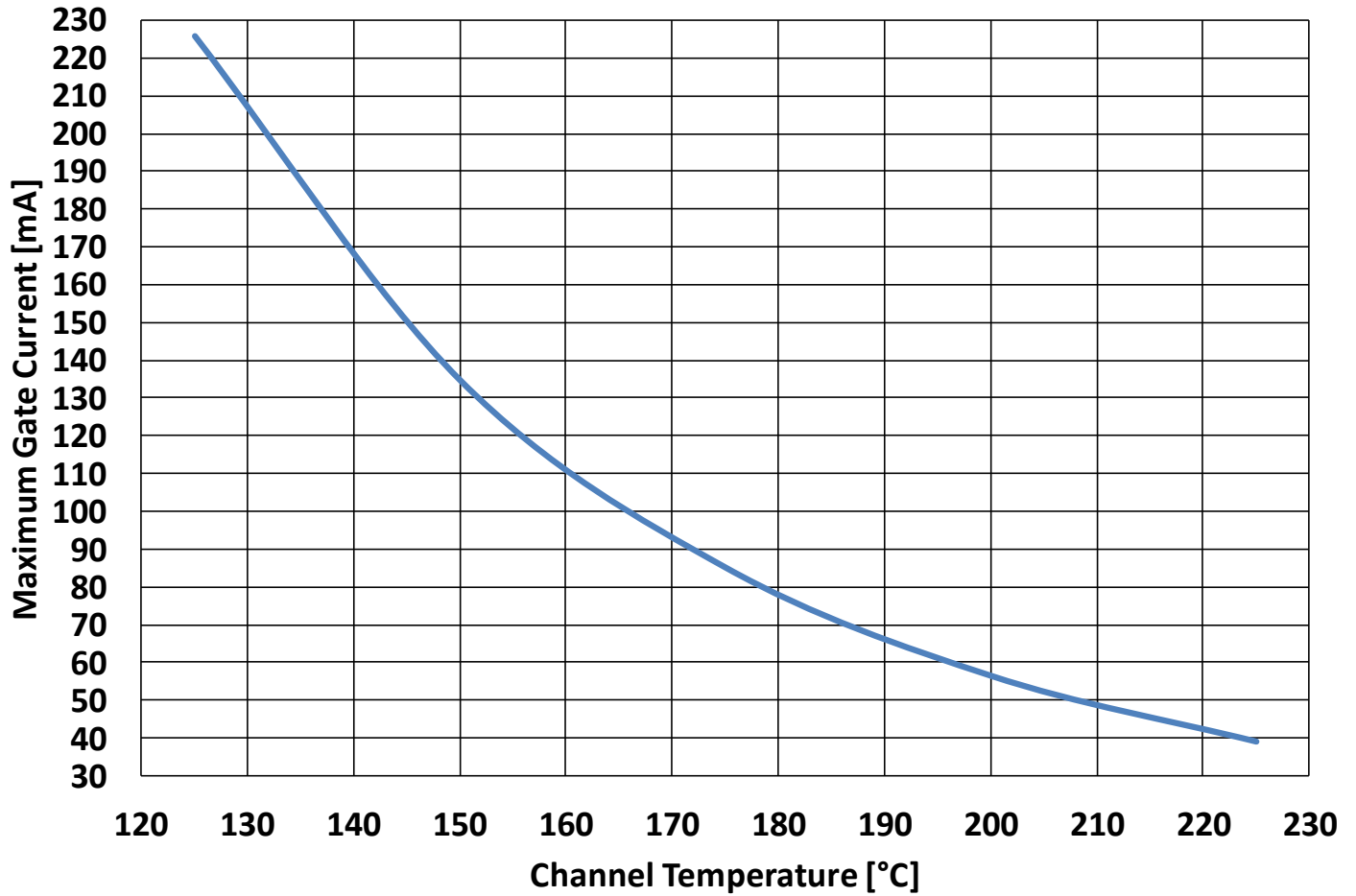
Parameter ¹	Conditions	Values	Units
Thermal Resistance, IR (θ_{JC})	85 °C Case	0.34	°C/W
Peak Channel Temperature, IR (T_{CH})	94.5 W Pdiss, CW	117	°C
Thermal Resistance, IR (θ_{JC})	85 °C Case	0.37	°C/W
Peak Channel Temperature, IR (T_{CH})	189 W Pdiss, CW	154	°C
Thermal Resistance, IR (θ_{JC})	85 °C Case	0.39	°C/W
Peak Channel Temperature, IR (T_{CH})	284 W Pdiss, CW	196	°C
Thermal Resistance, IR (θ_{JC})	85 °C Case	0.42	°C/W
Peak Channel Temperature, IR (T_{CH})	378 W Pdiss, CW	242	°C

Notes:

1. Refer to the following document [GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates](#)

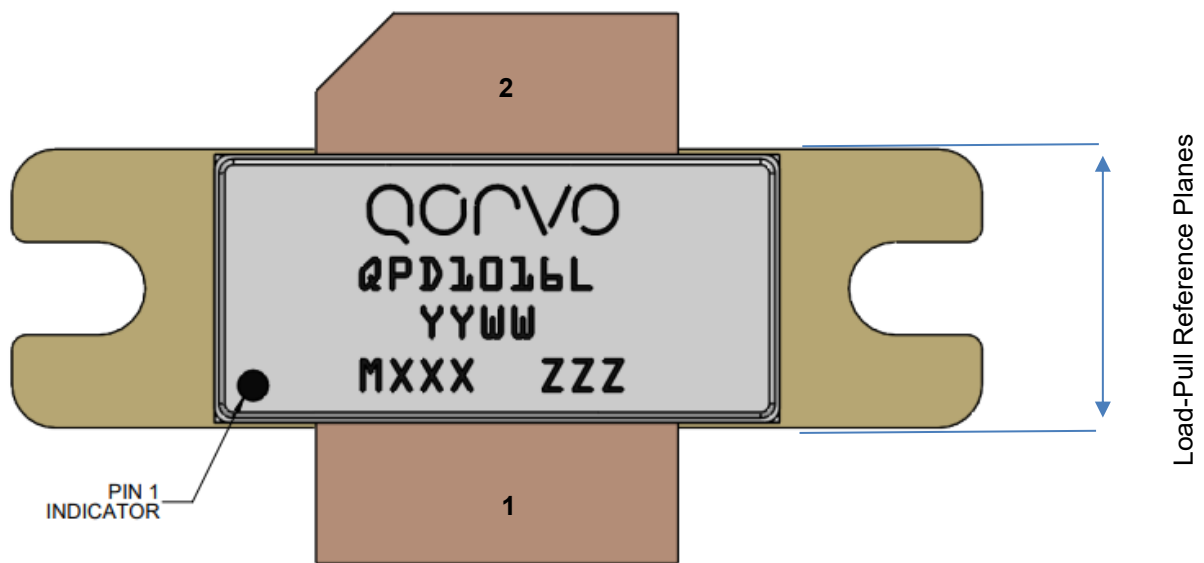
Maximum Gate Current

Maximum Gate Current Vs. IR Surface Temperature



Pin Configuration and Description¹

Note 1: The QPD1016L will be marked with the “QPD1016L” designator and a lot code marked below the part designator. The “YY” represents the last two digits of the calendar year the part was manufactured, the “WW” is the work week of the assembly lot start, the MXXX” is the production lot number, and the “ZZZ” is an auto-generated serial number.

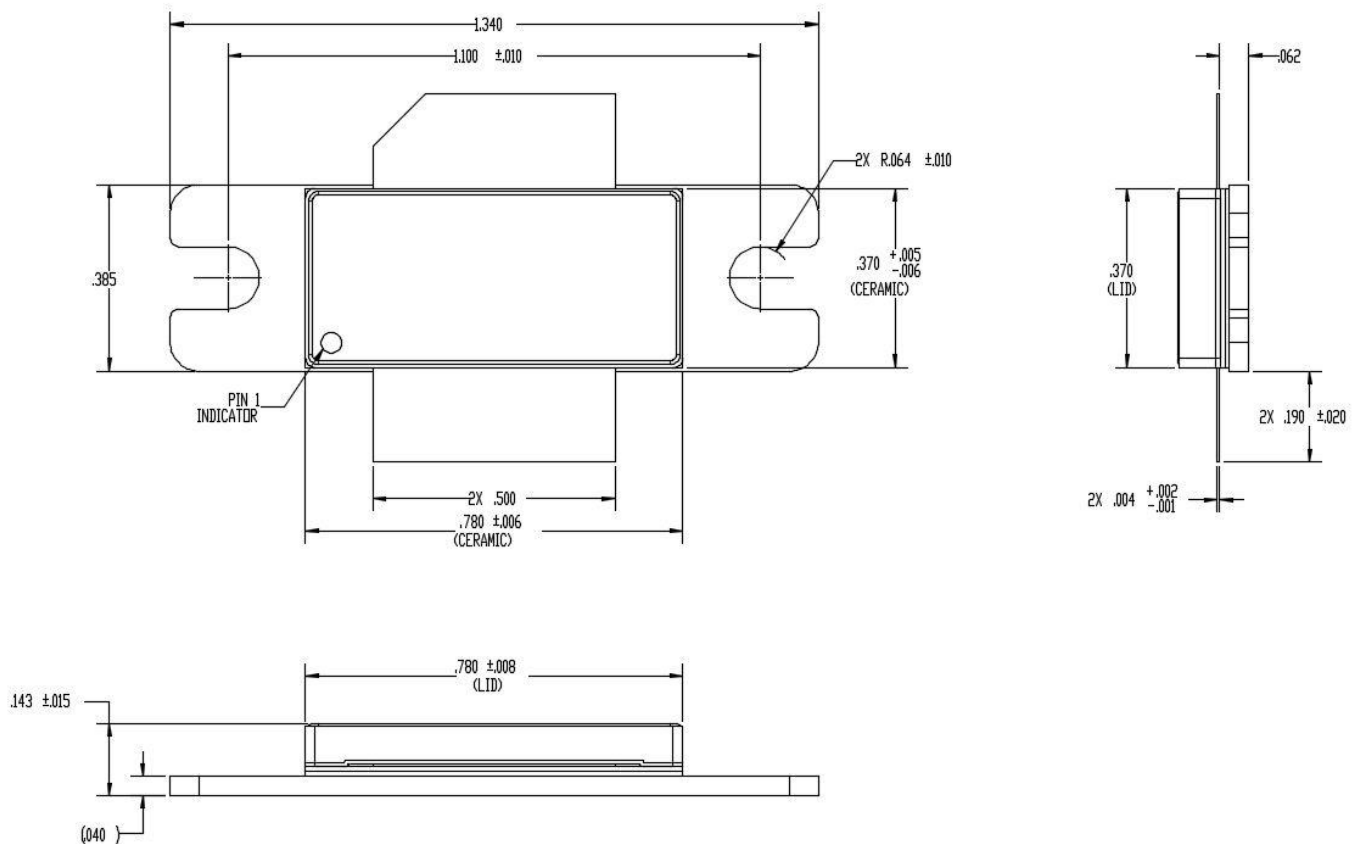


Pin	Symbol	Description
1	RF IN / V_G	Gate
2	RF OUT / V_D	Drain
3	Source	Source / Ground / Backside of part

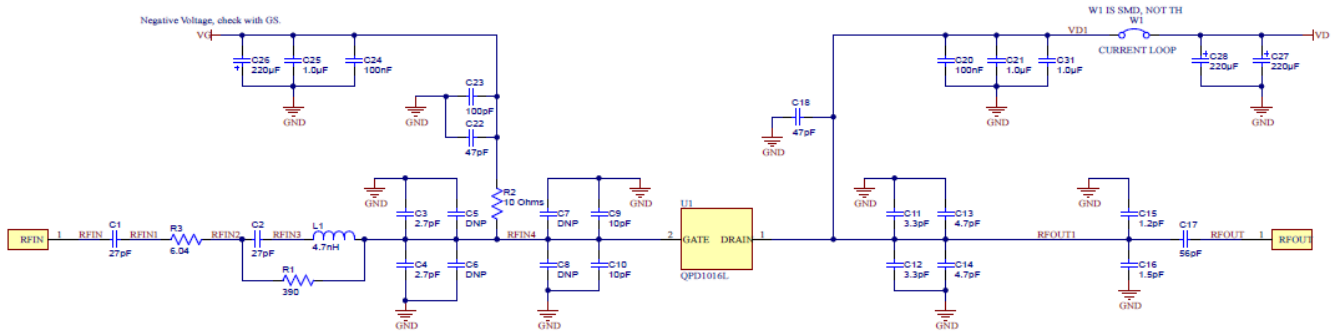
Mechanical Drawing¹

¹Notes:

1. Dimension tolerances are ± 0.005 inches for lengths and 0.5° for angles.
2. Material:
 Package base: Ceramic/Metal
 Package lid: Ceramic
3. Package exposed metallization is gold plated.
4. Part is epoxy sealed.
5. Part meets industry NI780 footprint.
6. Body dimensions do not include lid shift or epoxy run out which can be up to 20 mils per side.



1.2 – 1.4 GHz Application Circuit - Schematic



Bias-up Procedure

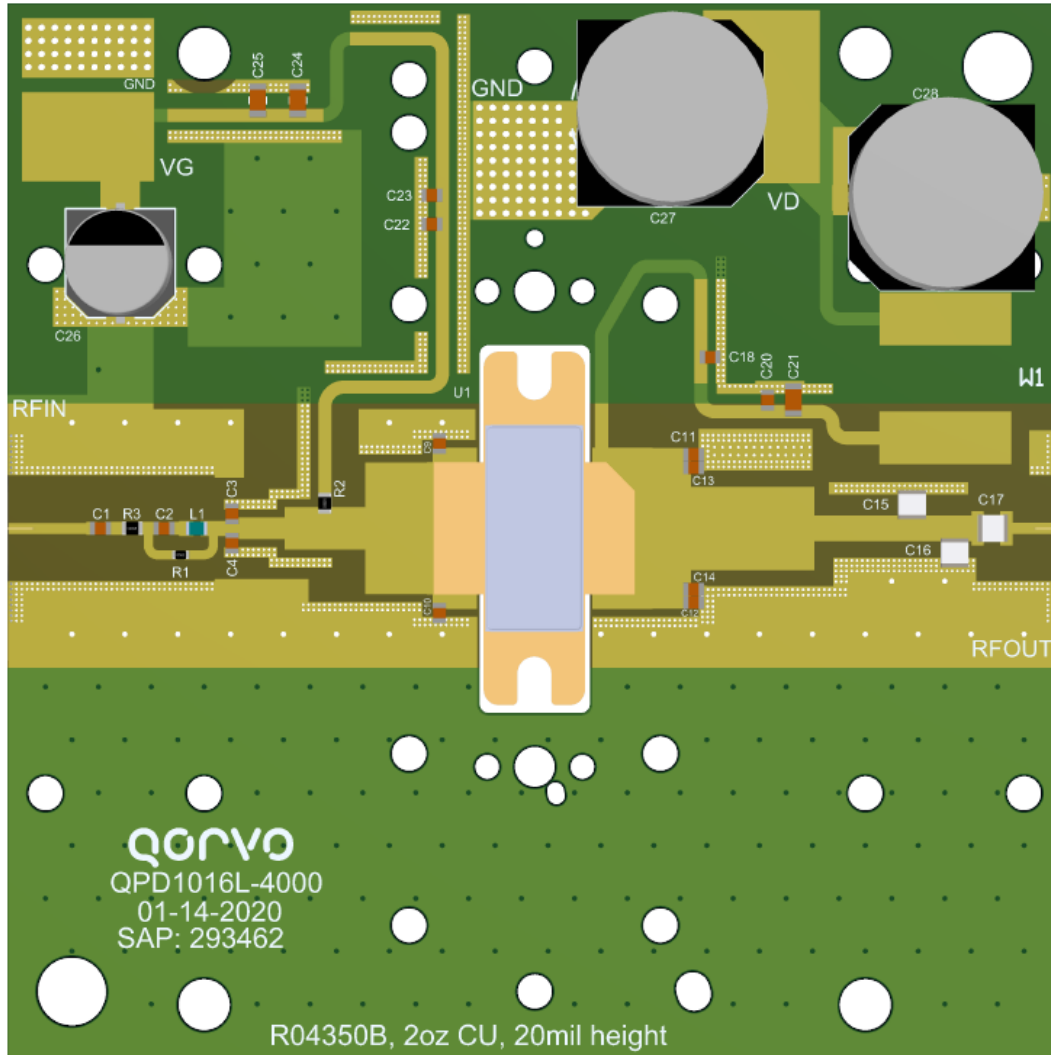
1. Set V_G to -4 V.
2. Set I_D current limit to 1100 mA.
3. Apply 50 V V_D .
4. Slowly adjust V_G until I_D is set to 1000 mA.
5. Set I_D current limit to 7 A (Pulsed operation)
6. Apply RF.

Bias-down Procedure

1. Turn off RF signal.
2. Turn off V_D
3. Wait 2 seconds to allow drain capacitor to discharge
4. Turn off V_G

1.2 – 1.4 GHz Application Circuit - Layout

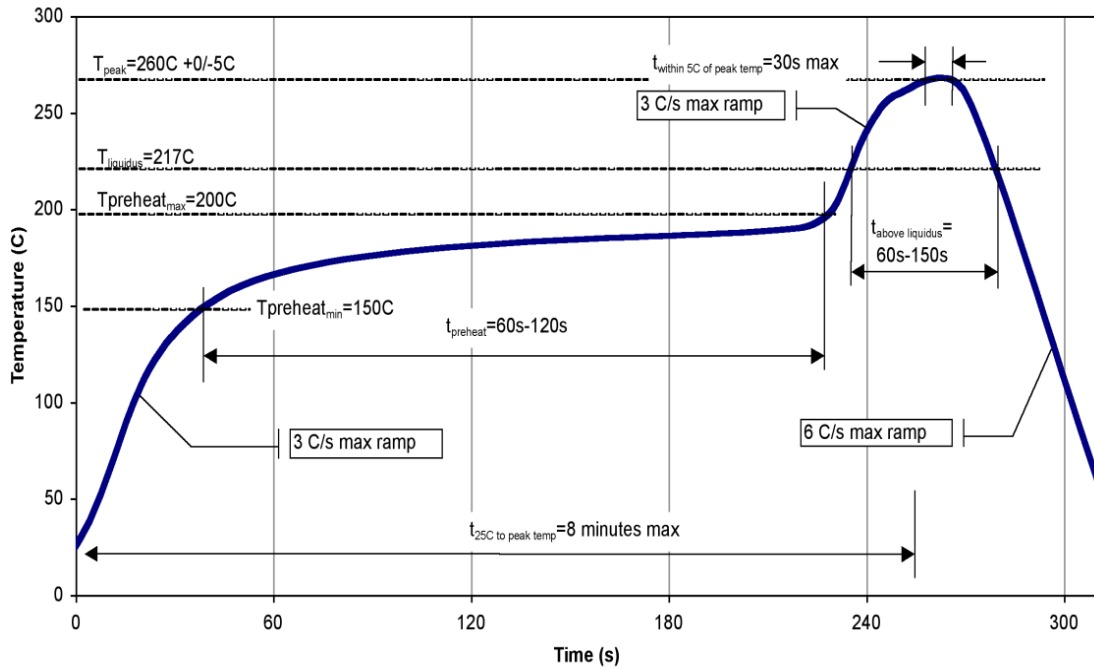
Board material is RO4350B 0.020" thickness with 2oz copper cladding. Overall EVB size is 3.98" x 3.98".



1.2 – 1.4 GHz Application Circuit - Bill Of Material

Description	Ref. Des.	Manufacturer	Part Number
Capacitor 27 pF, 250V, 0805	C1, C2	Kyocera AVX	600F270FT250XT
Capacitor 2.7 pF, 250V, 0805	C3, C4	Kyocera AVX	600F2R7BT250XT
Capacitor 10 pF, 250V, 0805	C9, C10	Kyocera AVX	600F100FT250XT
Capacitor 3.3 pF, 250V, 0805	C11, C12	Kyocera AVX	600F3R3BT250XT
Capacitor 4.7 pF, 250V, 0805	C13, C14	Kyocera AVX	600F4R7BT250XT
Capacitor 1.2 pF, 2%, 500V, 1111	C15	Kyocera AVX	800B1R2CT500X
Capacitor 1.5 pF, 2%, 500V, 1111	C16	Kyocera AVX	800B1R5CT500X
Capacitor 56 pF, 2%, 500V, 1111	C17	Kyocera AVX	800B560JT500X
Capacitor 47 pF, 5%, 250V, 0805	C18, C22	Kyocera AVX	600F470JT250XT
Capacitor 100 pF, 250V, 0805	C20, C23	Kyocera AVX	600F101JT250XT
Capacitor, 0.1 uF, 10%, 100V X7R, 1206	C19, C24	Kyocera AVX	12061C104K4T2A
Capacitor, 1 uF, 20%, 100V X7R, 1206	C21, C25	Murata	GRM32ER72A105MA01L
Capacitor 220 uF, 20%, 100V, Electrolytic	C27, C28	Nichicon	UUJ2A221MNQ1MS
Capacitor 220 uF, 20%, 50V, Electrolytic	C26	Panasonic	EMVY500ADA221MJA0G
Resistor, 390 Ohm, 1%, 1/10W, 0805	R1	Vishay	CRCW0805390RFKEAHP
Resistor, 10 Ohm, 1%, 1/10W, 0805	R2	Panasonic	ERJ-6ENF10R0V
Resistor, 6.04 Ohm, 1%, 1/10W, 0805	R3	Yageo	RC0805FR-076R04L

Recommended Solder Temperature Profile



Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1B (500V)	ANSI/ESD/JEDEC JS-001
ESD – Charged Device Model (CDM)	Class C3 (1000V)	ANSI/ESD/JEDEC JS-002
MSL – Moisture Sensitivity Level	MSL3	IPC/JEDEC J-STD-020



Caution!
ESD-Sensitive Device

Solderability

Compatible with both lead-free (260°C max. reflow temp.) and tin/lead (245°C max. reflow temp.) soldering processes. Solder profiles available upon request.

Package lead plating is NiAu. Au thickness is 60 microinches minimum.

RoHS Compliance

This part is compliant with 2011/65/EU RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment) as amended by Directive 2015/863/EU.

This product also has the following attributes:

- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A (C₁₅H₁₂Br₄O₂) Free
- PFOS Free
- SVHC Free
- Lead Free



Contact Information

For the latest specifications, additional product information, worldwide sales and distribution locations:

Web: www.qorvo.com

Tel: 1-844-890-8163

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